June 12, 2020

Mr. David Albright
Manager, Groundwater Protection Section
Water Division
U.S. EPA Region IX, (WTR-4-2)
75 Hawthorne Street
San Francisco, California 94105

**Re: Underground Injection Control (UIC) Permit Application No. R9UIC-AZ3-FY19-1
Florence Copper Project, Florence Arizona**

Dear Mr. Albright:

Florence Copper Inc. (Florence Copper) is submitting the following in response to the letter request for additional information by the U.S. Environmental Protection Agency (USEPA) received via email on May 15, 2020. In the letter, the USEPA has requested additional information to clarify, modify, or supplement materials submitted with the Underground Injection Control (UIC) Permit Application No. R9UIC-AZ3-FY19-1 transmitted to the USEPA on October 4, 2019 (Application) and on November 5, 2019. Florence Copper's responses to each request are provided below under numbered headings that correspond to the USEPA's request letter enclosure.

Several of the Attachments to the application have been revised to reflect the responses to comments described below. Each of the responses provided below details where changes have been made to the Application. Each of the revised Attachments, complete with Tables, Figures, and Exhibits are provided with this comment response document. Please replace Attachments A, B, C, D, and F in your files with the revised Attachments provided herewith.

Request 1: Enclosure – Technical Review Comments on the March 16, 2020 Responses for Florence Copper UIC Class III Permit Application

Comment 1

The hydraulic conductivity (K) values for the LBFU and UBFU cited in the text of the application are much lower than those based on Brown and Caldwell (1996a; see table below) and ADWR (2010). Please explain the choice of value used. Was the decision-making for the original model considered authoritative for the purposes of modeling this site?

Table comparing hydraulic conductivity values from figures, tables, and text in the revised permit application.

Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7	Column 8	Column 9
Section/Table		Figures A-4 to A- 13	Figures 14A-16 through 14A-25	Page 11 of PDF	Attachment B, Table B-3	Table B-2	Section 14A.3.2.2 of model report (Exhibit A-8)	Table 14A-4 of Exhibit A--8
Content/Notes		Cross sections showing K assigned to model layers	Layer by layer K for model, 2012 model report (as per color code)	Text of application. Described as range for each of the model layers in the original model.	Measured K values for PTF wells in 2018. See Exhibit B-5 for model update report.	Measured K values for MGFU samples. Data from 1995 and 2011 (three data points.)	Original model report (2012). Data sources: ADWR (2010) and Brown & Caldwell (1996a)	Brown and Caldwell (2012) Original model
Page of PDF		49	120-129	11	409	408	84-87	146
Unit	Model Layer	K (ft/day)	K (ft/day)	K (ft/day)	K (ft/day)	K (ft/day)	K (ft/day)	K (ft/day)
UBFU	1	130 (h), 13 (v)	130	0.2 to 2.5	12 (n=1)		20-130	20-130 (h), 2-13 (v)
UBFU	2	130 (h), 13 (v)	130	0.2 to 2.5	12 (n=1)		20-130	20-130 (h), 2-13 (v)
MGFU/UBFU	3	1 (h), 0.01 (v)	1 to 10 (project area) and 130	0.2 to 2.5		Mean = 1.29 x 10^{-5} (n=3)		1-130 (h), 0.01 - 13 (v)
LBFU	4	20 (h), 2 (v)	5 to 25	0.2 to 2.5	2.1 (n=1)		5 - 25	5-25 (h), 0.5 - 2.5 (v)
LBFU	5	20 (h), 2 (v)	5 to 25	0.2 to 2.5	2.1 (n=1)		5 - 25	5-25 (h), 0.5 - 2.5 (v)
Exclusion Zone	6	1 (h), 1 (v)	1	0.2 to 2.5	0.54 (as per table footnote)		0.1 - 2.51	1 (h), 1(v)
Bedrock Oxide	7	0.57 (h), 0.57 (v)	0.57	0.2 to 2.5	0.54 (as per table footnote)		0.1 - 2.51	0.57 (h), 0.57(v)
Bedrock Oxide	8	0.57 (h), 0.57 (v)	0.57	0.2 to 2.5	0.54 (as per table footnote)		0.1 - 2.51	0.57 (h), 0.57(v)
Bedrock	9	0.1 (h), 0.1 (v)	0.1	0.2 to 2.5			0.0055 - 0.05	0.1 (h), 0.1(v)
Bedrock	10	0.1 (h), 0.1 (v)	0.1	0.2 to 2.5			0.0055 - 0.05	0.1 (h), 0.1(v)
Faults	N/A	6 (h), 6 (v)		0.2 to 2.5				2.51 (h), 2.51 (h)

Response to Comment 1

The hydraulic conductivity values which remained the same in the 2012 model and the 2019 model update represent the best available information regarding the hydraulic properties of the water bearing formations rendered in the respective models. Consequently, these values are considered authoritative until such time as additional data are developed. The APP and UIC permits requested for the commercial scale in-situ copper recovery (ISCR) wellfield will include a provision for additional aquifer tests to be conducted, and prescribed review and update of the groundwater model. As additional hydraulic conductivity data are developed, the groundwater flow model will be evaluated against the new data and they will be incorporated into the model as appropriate.

The table included in Comment 1 has been incorporated into this document with column numbers added at the top of each column for discussion purposes. Columns 1 and 2 contain the name of the geologic unit and the model layers assigned to represent those units, respectively. The hydraulic conductivity values listed in Columns 3 through 9 and their relationship to values used in the model are discussed below.

Column 3 lists the hydraulic conductivity values applied to each model layer depicted in the cross sections shown in Figures A-4 through A-13 of the UIC application. The cross sections shown in these figures depict a discrete area of the model domain representing approximately 1,000 feet around the Production Test Facility (PTF) wellfield. The color scale of hydraulic conductivity values shown on Figures A-1 through A-13 does represent the range of hydraulic conductivity values applied in the model.

Column 4 lists the hydraulic conductivity values shown of Figures 14A-16 through 14A-25 of the 2012 groundwater model report. The values shown on these figures are consistent with those shown on Figures A-4 through A-13 of Attachment A of the UIC application and represent the hydraulic conductivity values applied across the entire model domain; an area greater than 100 square miles. The hydraulic conductivity values listed in Column 3 are within the range of hydraulic conductivity values listed in Column 4.

Column 5 lists hydraulic conductivity values presented in the text on page 11 of Attachment A of the UIC application. The values listed (0.2 to 2.5 feet per day) represent a typographical error. The correct values are 0.1 to 130 feet per day as shown on Figures A-4 through A-13 of Attachment A and Figures 14A-16 through 14A-25 of the 2012 groundwater model report.

Column 6 lists hydraulic conductivity values reported in Table B-3 of the UIC application which were derived from aquifer testing conducted at the PTF wellfield during 2018. The hydraulic conductivity values derived from these aquifer tests fall within the range of values developed from earlier aquifer tests conducted across the Florence Copper property as described in Exhibit B-2 of the UIC application. Aquifer tests conducted at the PTF wellfield are most representative of the planned ISCR well and formation performance because the wells used for testing were constructed using the same design to be applied to the planned commercial scale ISCR wellfield. The PTF wells are screened across the entire planned injection and recovery interval, and are constructed using materials, screen geometry and dimensions that are the same as the proposed commercial ISCR wells. The hydraulic conductivity values derived from aquifer tests at the PTF well field validate the values used to represent the bedrock oxide unit in the groundwater model, which were derived from earlier aquifer testing described in Exhibit B-2 of the UIC application. The primary difference between the aquifer tests conducted at the PTF wellfield and those described in Exhibit B-2, is the fact the PTF wellfield aquifer tests were conducted in wells designed for ISCR operations, which fully penetrated the planned injection zone. By contrast, the aquifer tests described in Exhibit B-2 were conducted at wells constructed with differing screened intervals and constructed at different depths within the planned injection zone. The hydraulic conductivity values listed in Column 6 are lower than the hydraulic conductivity values used to represent characteristics of the upper basin fill unit (UBFU), lower basin fill unit (LBFU), and bedrock oxide unit in the groundwater model. The higher hydraulic conductivity values will allow the model to simulate a greater distance of migration within a fixed period of time than would the lower hydraulic conductivity values. The higher values used in the groundwater model are expected to conservatively represent higher groundwater flow rates.

Column 7 lists one hydraulic conductivity value for the middle fine grain unit (MFGU) which is a calculated mean from Table B-2 of Attachment B of the UIC application. This value represents hydraulic conductivity of the MFGU as determined from laboratory testing of MFGU core samples. The value listed in Column 7 is lower than the value used in the groundwater model to represent characteristics of the MFGU. The higher value was selected for use in the groundwater model to represent a higher groundwater flow rate to conservatively estimate impacts of fluid migration.

Column 8 lists hydraulic conductivity values reported in documents used to support the 2012 groundwater flow model development. The data sources cited in Column 8 reflect value referenced to describe the variability of hydraulic conductivity in each of the water bearing units. The values listed in Column 8 for the UBFU and LBFU are the same as the values listed in Column 4 and represent reasonable hydraulic conductivity estimates for those water bearing units. The hydraulic conductivity values listed in Column 8 for the bedrock oxide represent a range of values that includes the value used in the 2012 groundwater model. The hydraulic conductivity value used in the 2012 groundwater model was derived as an average of hydraulic conductivity values reported in Exhibit B-2 for selected aquifer tests conducted in the bedrock oxide unit. The specific aquifer tests used to derive the average were spanned the breadth and depth of the planned commercial ISCR wellfield area. The average value (0.57 feet per day [ft/day]) was later validated by aquifer testing conducted at the PTF wellfield which produced a hydraulic conductivity value of 0.54 ft/day using wells that span the full length of the injection interval. The two values (0.54 and 0.57 ft/day) are close enough together to be considered to be mutually representative. Consequently, the value 0.57 ft/day remained in the updated model, which represents a conservatively higher hydraulic conductivity that is still representative of formation conditions.

Column 9 lists the hydraulic conductivity values applied in each model layer throughout the entire model domain (an area greater than 100 square miles). The values used in the 2012 groundwater model were derived from site-specific aquifer testing, published data sources, and provisional data obtained from the Arizona Department of Water Resources (ADWR). The hydraulic conductivity values used in the 2012 groundwater model also included conservative estimates in localized areas (e.g., faults) and examine the potential for greater flow in these areas. The hydraulic conductivity values used to represent the bedrock oxide unit in the 2012 groundwater model were validated through aquifer testing conducted at the PTF wellfield. Aquifer testing at the PTF wellfield also included wells that penetrate at least one fault plane, providing additional data regarding the anticipated flow properties of mapped faults. The hydraulic property values in the 2019 model update remained the same as the values used in the 2012 model except that the hydraulic conductivity values for the faults in the model were set at 6 ft/day, which is at least 10 times higher than the representative hydraulic conductivity values used for the oxide bedrock layers (Model Layers 7-10). The hydraulic conductivity values used in the 2012 model and the 2019 model update represent the best available information regarding the hydraulic properties of the water bearing formations rendered in the models. Consequently, these values are considered authoritative until such time as additional hydraulic conductivity data are developed.

Comment 2

The application text on Page A-6 in the application, states "...that the original model used porosity values ranging between 2 and 20 percent." Table 1 does not contain any porosity values as low as 2 percent in the column titled "Range of Modeled Porosity Values."

Table 1. Porosity in model compared to porosity measured by neutron logging (Table B-4 in the UIC application, page 100).

Model Layer or Unit	Range of Modeled Porosity Values	Average Porosity Measured by Neutron Logging (I-01, I-02, I-03, I-04, and R-01)
Model Layers 1 and 2 (UBFU)	0.13 - 0.2	0.12
Model Layer 3 (MFGU/UBFU)	0.15 - 0.2	0.12
Model Layer 4 and 5 (LBFU)	0.2	0.12
Model Layers 6-10 (Bedrock Oxide)	0.08 for Model Layers 6-8 0.05 for Model Layers 9-10	0.08

Please clarify the difference between the application text and Table 1.

Response to Comment 2

Table B-4 in the UIC application is correct, the lower bound value for the porosity in the model is conservatively set at 5 percent. The text of Attachment A has been revised accordingly.

Comment 3

In FCI's March 16, 2020 response to EPA comment 10, Section B.4.2 of the Application has been revised to include discussion of potential for the dissolution of mineral material to change formation permeability and porosity.

The application does not discuss the potential for changes in the porosity and permeability in the formation due to removal of material from fractures during ISCR operations. EPA's question in comment 10 is focused specifically on dissolution of materials in fractures (not the matrix). FCI's response does not answer the question regarding whether enough material will be dissolved out of the fractures to change the associated permeability. According to the response, FCI anticipates that the volume of material removed from the fractures (and possible precipitation of authigenic minerals) will not affect porosity and permeability and that precipitation would compensate in part.

Please provide details about the characteristics of the formation related to this occurring. How much ore material is present in the faults and fractures that is expected to be dissolved? What is the possible effect *on permeability and porosity from dissolution of material within the fractures? How much precipitation of new mineral phases is anticipated?*

Response to Comment 3

The formation contains on average only 0.25 percent recoverable copper, or about 5 pounds of copper per ton of rock. The dominant copper mineral is chrysocolla, a complex copper silicate, (CuAl)2H2Si2O5(OH)4•nH2O, and most of it was deposited post-fracturing, and occurs mainly on fracture surfaces. As it dissolves, it leaves behind clay-like solids in which other cations, especially aluminum, replace the copper. During leaching, some gangue minerals, notably feldspars and calcite, CaCO3, also dissolve partially, releasing some aluminum, potassium, sodium, and calcium. The most reactive feldspars include orthoclase, KAlSiO4, and plagioclase, (Na,Ca)(Al,Si)4O8.

The net effect of the leaching process is that the recirculated leaching solution increases in total dissolved solids (TDS) up to approximately 25,000 milligrams per liter (mg/L), or roughly 2.5 weight percent, representing the net amount of copper and gangue minerals dissolved during leaching. Some of the calcium precipitates as gypsum when the solubility of calcium, about 500 mg/L, is exceeded. As the rock dissolves and the circulating solution gradually approaches equilibrium with the solubility products of the gangue minerals, solid alteration products are created or precipitated, reducing the net volume change. In addition to gypsum, CaSO4•2H2O, one of the new minerals is K-mica, KAl2(AlSi3O10)(OH)2. As the circulating solutions approach saturation, coprecipitation of these minerals reduces the net change in porosity to a rate that is near neutral. Depending on localized mineralogy, the net volume change in mineral material during leaching can either be slightly positive or slightly negative.

Although no significant change in porosity is anticipated, it is useful to consider how a hypothetical change in porosity would affect solution flow through the formation. The measured formation porosity is 8 percent. A hypothetical change in porosity of 20 percent, either up or down, would change the formation porosity from 8 percent, down to 6 percent, or up to 10 percent. This level of change in porosity is low enough that it would not affect the overall hydraulic behavior of the orebody. This level of change would alter the amount of solution residing in the formation and would minimally affect fluid flow velocity and travel time from injection well to recovery well but would not have substantial impacts on wellfield performance. Attachment B of the Application has been revised to include this information.

Comment 4

In the March 16, 2020 response to EPA comment 16, Section A.3.1.2. of Attachment A has been updated to describe sensitivity analyses conducted to evaluate the effects of hydraulic conductivity and porosity on potential preferential groundwater flow pathways. Please explain why the 20% porosity decrease was chosen for the sensitivity analysis.

Response to Comment 4

A decrease in porosity was used for sensitivity analysis because it is an adjustment that will cause fluid to migrate further in a given period time, thus conservatively depicting the effects of porosity on fluid migration. A decrease in the porosity value has the effect of forcing a fixed quantity of water through smaller openings in the formation, thereby increasing groundwater flow velocity and increasing the distance that fluid may migrate in a given period of time. By contrast, increasing the porosity slows groundwater flow velocity and reduces the distance of fluid migration. Adjusting the porosity downward provides a conservative representation of conditions that may cause fluid to migrate further than expected.

A 20 percent porosity reduction was selected for the sensitivity analysis because it is a large enough variation to notably perturb the model, providing visual discernment for the extent of additional migration of solution in comparison with the baseline case. The sensitivity analysis approach is consistent with sensitivity analysis procedures described in *Applied Groundwater Modeling Simulation of Advective Flow and Transport*, Anderson and Woessner (1992). Attachment A of the Application has been revised to include this information.

Comment 5

It is possible for ISR fluids to migrate upward into the LBFU within the pressure influence of the injection wells regardless of the drawdown caused by offsetting recovery wells. The application proposes installing just one Annular Conductivity Device (ACD) within 10 feet of the top of the MFGU or no more than 200 feet above the top of bedrock where bedrock is separated from the MFGU by more than 200 feet. That could allow ISR fluids to potentially migrate into the USDW before being detected, especially where injection wells are screened in a fault zone. Please revise the proposed placement of ACDs to include locations above and below the LBFU/MFGU contact and closer than 200 feet from the top of bedrock where separated from the MFGU by more than 200 feet to provide early detection of vertical migration.

The balance of injection and recovery of fluids may be maintained in the active wellfield but may vary from a balance at various five-spot patterns within the wellfield due to localized faulting and fractures that could cause preferential flow in a lateral or vertical direction. Please identify strategic locations for placement of monitoring wells in the LBFU and UBFU that will allow early detection of vertical fluid migration in the direction of the non-exempt portion of the LBFU and UBFU above the orebody and lateral to the bedrock oxide unit within the AoR. Provide justification for the proposed locations. Place monitoring wells to monitor above fault zones where they terminate at the bedrock/LBFU contact.

Response to Comment 5

Placement of the ACDs

The placement of the ACDs 10 feet above the MFGU, or 200 feet above the bedrock LBFU contact where the contact is separated from the LBFU by more than 200 feet, is consistent with UIC permits R9UIC-AZ3-FY11-1 and AZ396000001, which were formerly issued for the Florence Copper site. Nevertheless, Florence Copper acknowledges that the placement of the ACDs as described may allow solution to potentially migrate 10 feet into an underground source of drinking water (USDW) before detection.

In response to this comment, Florence Copper proposes to install the ACDs at a point 10 feet below the MFGU, or no more than 190 feet above the bedrock LBFU contact, where the contact is separated from the LBFU by more than 200 feet. This placement of the ACDs will provide an indication of solution migration at the vertical limit of the Aquifer Exemption before a hypothetical solution excursion would reach the USDW. The ACDs will be installed at this level on every ISCR well within the commercial wellfield.

Florence Copper also proposes to install additional ACDs at a greater depth within the exempted aquifer to provide early warning of potential vertical solution migration. Florence Copper proposes to install six ACDs within each 500 by 500 foot resource block at a depth of 20 feet above the bedrock-LBFU contact to serve as an early warning of vertical migration of injected fluid. This number of ACDs represents 10 percent of the wells to be installed within each resource block. Partial resource blocks located at the edge of the ISCR wellfield contain fewer wells than the full resource blocks and will have early warning ACDs installed on 10 percent of the ISCR wells.

The early warning ACD installation will be prioritized in each resource block as follows:

1. Where mapped faults transect a resource block, two ACDs will be installed on wells that are projected to penetrate the fault plane. The additional four ACDs will be installed at locations distributed across the resource at approximate even spacing.
2. Where mapped faults transect a corner or small portion of a resource block, a minimum of one ACD will be installed on a well that is projected to penetrate the fault plane. The remaining ACDs will be installed at locations distributed across the resource at approximate even spacing.
3. In partial resource blocks located at the edge of the PTF well field, an early warning ACD will be installed on at least one well if fewer than 10 wells are planned for the resource block, or will be installed on 10 percent of the wells in the block if more than 10 wells are planned for the resource block. ACDs installed in partial resource block as at the edge of the wellfield will be installed in areas where mapped faults are projected or will be approximately evenly distributed across the resource block if no mapped faults transect the resource block.

Installation of early warning ACDs on 10 percent of the ISCR wells will provide a dataset that will support statistical analysis of monitoring results to demonstrate baseline conditions and assess changes in baseline conditions. Prioritizing installation of the ACDs at mapped faults will provide early warning of potential vertical migration of injected fluid along those faults. Attachment C of the Application has been revised to include this information.

Additional Monitoring Wells

Florence Copper Proposes to install four monitoring wells (M62-LBF, M63-LBF, M64-LBF, and M65-LBF) to monitor groundwater quality at bedrock/LBFU contact at locations where mapped faults transect the AOR, between the edge of the ISCR wellfield and the AOR boundary. These wells will serve to monitor for potential fluid migration through faults into the LBFU at the edge of the ISCR wellfield.

Florence Copper proposes to install six monitoring wells at the western edge of the ISCR wellfield where a thin section of non-exempted LBFU overlies the ore body. Three of the monitoring wells (M67-LBF, M68-LBF, and M70-LBF) will be constructed with the well screens placed in the center of the 200-foot thick exempted aquifer area, between the ore body and the non-exempted LBFU. Three of the monitoring wells (M66-UBF, M69-UBF, and M71-UBF) will be constructed adjacent to the LBFU wells but will be screened at the bottom of the UBFU, above the exempted aquifer and above the ore body. These monitoring wells will provide early warning of lateral and vertical migration of injected fluid toward non-exempted LBFU which overlies the ore body, and the UBFU. The planned locations of the fault and USDW monitoring wells are shown on Figure A-17. The planned completion depths of the USDW monitoring wells are shown on the revised cross sections in Figures B-6, B-7, and B-8. Attachment A of the Application has been revised to include Figure A-17, and Attachment B has been revised to include the revised cross sections.

The early warning ACDs described above, will be installed on wells penetrating mapped fault planes, and will provide early warning of potential vertical fluid migration along those fault planes, prior to migration reaching a USDW.

Comment 6

The March 16, 2020 response to EPA comment 24 describes the monitoring results confirming that no migration of injected fluid has occurred at the well casing/cement seal interface. The PTF's ACD data were provided in Exhibit C-1 of the Attachment C of the Application. Please provide a discussion of the criteria by which the ACD data indicates an absence of injected fluid, both in absolute magnitude and decrease/increase in resistance at the ACD.

Response to Comment 6

The PTF wellfield ACDs consist of two electrodes placed on each non-conductive well casing and spaced 1 meter apart. Monitoring of the ACDs at the PTF wellfield is performed by inducing an electrical current across the two electrodes and measuring the resistance between the electrodes. The injected solution is highly conductive, and if the solution were to migrate vertically to the area between the electrodes, the resistivity would decrease significantly. The change in contact resistance will be directly influenced by ionic fluids coming in close proximity to the sensors. It is known that the contact resistance will decrease significantly when in contact with these fluids (Rucker et al., 2014) and the change can cause the shift in contact resistance. This shift would be sufficiently large enough to distinguish it from environmental or system drift.

The longevity of the annular conductivity sensors is anticipated to be longer than the seals themselves. The sensors have been constructed from 316 stainless steel, which is highly resistant to corrosion. However, if corrosion were to occur, the contact resistance would gradually increase over time. The corrosion causes the surface of the sensor that is in contact with the surrounding formation to oxidize and this oxidation inhibits the passage of electrical current between the sensors. The direction of change due to corrosion is opposite of what is expected during a break in seal integrity including polarity, frequency, and magnitude of change. Corrosion would cause an increase in contact resistance that is long lived and at a low rate; a breach of the concrete seal would cause a decrease in contact resistance that is short lived and abrupt.

The resistivity values measured at the first monitoring event in September 2018 ranged from 46.88 to 77.95 ohms. Resistivity values measured at the most recent monitoring event in January 2020 ranged from 49.48 ohms to 84.33 ohms. The resistivity values measured at the PTF ACDs have generally increased since the initial baseline monitoring was conducted and during PTF operations. This fact demonstrates that no vertical migration of injected fluid has occurred at the well casing/cement seal interface.

Of the 11 ACDs installed at the PTF wellfield, 9 have shown a generally increasing resistivity trend, and 2 ACDs have shown a slight decreasing trend of similar magnitude. The variability of resistivity values measured at the PTF ACDs show a similar magnitude of change among wells with increasing and decreasing trends, and none of the values have fallen below the minimum resistivity value measured prior to the commencement of PTF operations. The change of resistivity values measured at ACDs on the two wells with a decreasing trend is less than the amount of change that would be generated from vertical migration of injected fluid. The observed changes in resistivity values measured at PTF ACDs, both increased and decreased, are the result of sensor drift resulting from the ambient factors described above.

Comment 7

In FCI's March 16, 2020 response to EPA comment 29, Section D.3.5 of Attachment D of the Application has been revised to include discussion of the planned project duration relative to laboratory analysis of site-specific formation material and PTF derived ISCR solutions. The response does not adequately explain how the laboratory data and geochemical modeling support 4 years for extraction followed by 2 years of rinsing. Please describe more fully how the experimental data and geochemical modeling support the 4 years of leaching and 2 years of rinsing. As referenced in Exhibit D-7, please provide Exhibit 10-1, which is described as the 2019 geochemical modeling update.

Response to Comment 7

Florence Copper conducted a laboratory program for the purpose of leaching core samples collected from borings drilled within the PTF wellfield area prior to construction of the PTF wellfield. Core samples were leached and rinsed with the same solutions and formation applied at the PTF wellfield. The laboratory program included a series of tests using sealed flow-through boxes, wherein the boxes were connected in a series to simulate a lengthened flow path through formation material. Manometers were located between boxes to allow observation of the pressure drop due to friction loss at each stage of the flow path. The tests were conducted at a flowrate of 7 liters per day and a hydrostatic head of 12 inches on the solution entering the first box. There was no pressure drop, either overall or between any pair of boxes, during leaching. This is consistent with visual observation of all of the core segments following leaching and rinsing. The leached residues were free of any evidence of flow blockages and showed essentially complete removal of the characteristic blue color of chrysocolla. Some gypsum was visible on fracture surfaces, but it was granular and unconsolidated.

Laboratory simulations of copper recovery were completed after approximately 150 to 200 days each of leaching and rinsing. However, the tests represented ideal conditions with essentially 100 percent solution/solid contact (100 percent sweep efficiency), and flowrates were higher per unit area contacted than those expected in the commercial well field. The geochemical model projections used to support the permit application included an estimated sweep efficiency as a function of time and indicated completion of leaching and rinsing within approximately 2.5 to 4 years. However, the formation has variable mineralogy, fracture intensity, clay and calcite content, and thickness, so we have conservatively assumed a total of 6 years for copper extraction and rinsing of the formation. Attachment D of the Application has been revised to include this information.

The materials provided in Attachment D-7 are components of the APP application submitted to ADEQ on June 12, 2019. The Exhibit 10-1 referenced in those materials is the same geochemical modeling report submitted as Attachment D-3 of the UIC application. A copy of Exhibit 10-1 of the APP application is included with this comment response.

Comment 8

In FCI's March 16, 2020 response to EPA comment 32, Section D.2.2 of Attachment D of the Application has been revised to include discussion of scalability of the hydraulic control method applied at the PTF to the planned commercial ISCR wellfield. However, the application does not describe how a loss of hydraulic control in a small subset of the wellfield could impact nearby portions of the wellfield. Please explain whether a loss of hydraulic control in one part of the wellfield would necessitate an adjustment in operations (e.g., injection or withdrawal) in adjacent parts of the wellfield (other five-spots) to compensate for increased net injection.

Response to Comment 8

A loss of hydraulic control in a small subset of the ISCR wellfield would be indicated by one of the following two conditions:

1. Injected solution is detected at full strength in one or more of the observation wells installed at the edge of the ISCR well field (indicated by a TDS equal to or greater than that of the injected fluid based on daily comparison), or
2. One or more injection wells creates a mounding condition that overcomes the inward gradient at the edge of the ISCR wellfield.

If these conditions occur, a loss of hydraulic control is indicated, and the corrective measures include decreasing injection and increasing recovery pumping at selected wells to re-establish hydraulic control.

If injected solution is detected at one or more observation wells, or a mounding condition has overcome the inward hydraulic gradient, the corrective measures include:

1. Stop injection at the nearest injection well(s).
2. Increase solution extraction from the recovery wells surrounding the injection wells that have been idled to increase or re-establish the inward hydraulic gradient.
3. Increase solution extraction from the 5-spots adjacent to the idled wells.
4. Monitor water levels in the recovery, observation, and perimeter wells to confirm that the inward hydraulic gradient has been re-established.
5. Monitor water quality daily at the observation wells in which solution was detected.

Each of these indicators, and corrective measures have been added to a revised version of the operations plan previously submitted as Exhibit D-2 of Attachment D of the UIC application. The revised operations plan (Exhibit D-2) is included with the revised version of Attachment D.

Comment 9

In FCI's March 16, 2020 response to EPA comment 39, a draft of the financial assurance mechanism was added to Attachment F of the Application under Exhibit F-3. The complete list of wells to be plugged and abandoned after cessation of ISCR operations is listed in the Application under Exhibit F-4. These exhibits are not in the right order. Please switch the exhibits F-3 and F-4 to the correct sheet identifying each of them.

Response to Comment 9

Exhibits F-3 and F-4 have been placed in the correct order, and the revised Exhibits are provided with this comment response.

References

Anderson, M.P., Woessner, W.W., and Hunt, R.J., 1992. *Applied Groundwater Modeling Simulation of Advective Flow and Transport.*

Rucker, D.F., Crook, N., Winterton, J., McNeill, M., Baldyga, C.A., Noonan, G., and Fink, J.B., 2014. Real-Time Electrical Monitoring of Reagent Delivery during a Subsurface Amendment Experiment. Near Surface Geophysics 12 (1), 151-163.

Please contact me at 520-316-3710 if you require any additional information.

Sincerely,
Florence Copper Inc.

Brent D. Berg
General Manager

cc: Maribeth Greenslade, ADEQ
Anita Thompkins, USEPA Office of Groundwater and Drinking Water